NIST
National Institute of Standards and Technology
Technology Administration, U.S. Department of Commerce

Ethernet/IP Performance Metrics

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Overview

- Introduction
- Conformance vs. Performance
- Overview of ODVA Ethernet/IP Implementors Workshop
- Suggestions
- Comments?

Introduction

- Most industrial machines will be networked
- Most commercial networked devices are both conformance and performance tested.
- Most industrial networked systems conformance tested but NOT performance tested

Conformance vs. Performance

- Conformance testing proves a device meets the basic specification and doesn't break
- Performance testing proves how well a device works under different conditions
- Not all devices break when something goes wrong
- Devices can be tailored to tests, but performance tests give basic comparison of different devices (vehicle city/highway gas mileage)

Conformance vs. Performance

- Conformance Tests
  - Does the device…
  - Send/receive properly formatted messages?
  - Shutdown when it receives improper messages?
  - Perform the desired task(s)?
  - Use the correct physical characteristics?
  - Etc.
- Performance Tests
  - Does the device…
  - Handle message prioritization correctly?
  - Continue to work at low/high network loads?
  - Suffer from OS overhead?
  - Block on communications?
  - Handle multiple connections?
  - Etc.

Overview of ODVA Ethernet/IP Implementors Workshop

- May 22, 2002 – Ann Arbor, MI
- Major Topics Discussed
  - Terms & Definitions
  - IP Address Configuration Methods
  - Performance Requirements & Benchmarking
  - Workshop Interoperability Demonstration
- IP Address Configuration Methods
  - Rockwell IP Tool (BootP)
  - BootP vs. DHCP (DHCP Server, either client)

Overview of ODVA Ethernet/IP Implementors Workshop

- Performance Requirements & Benchmarking
  - Rockwell Presentation, *Brian Batkey*
    - Ran set of experiments to test Packet Rate, Connection Size, and Number of Connections vs. throughput
    - Propose performance specification with:
      - Packet Size vs. Rate
      - Connection Overhead vs. Number of Connections
      - Max Connections
    - Tests did not include:
      - Other class 3 CIP traffic
      - Non-CIP traffic
      - Rejected Multicast Packets

Overview of ODVA Ethernet/IP Implementors Workshop

- Performance Requirements & Benchmarking
  - BCIT Presentation, *Eric Byres*
    - Most commercial networking equipment uses RFCs for performance tests (RFC 1242, 2285, 2544, 2889)
      - RFC 1242 – Benchmarking Terminology for Networking Interconnection Devices
      - RFC 2285 – Benchmarking Terminology for LAN Switching Devices
      - RFC 2544 – Benchmarking Methodology for Networking Interconnection Devices
      - RFC 2889 – Benchmarking Methodology for LAN Switching Devices
    - Need to define something similar for industrial networked devices and equipment
    - Testing should be done at all ISO levels, not just TCP/UDP and below
    - Closed loop tests for both command/response and command/action

Overview of ODVA Ethernet/IP Implementors Workshop

- Performance Requirements & Benchmarking
  - Participants from GM, BCIT, Rockwell, and NIST would develop a proposed set of metrics and tests for next meeting (July 10-11, 2002)
- Workshop Interoperability Demonstration
  - GM sponsored workshop to demonstrate interoperability of Ethernet/IP equipment
  - Many different companies & industries represented
  - GM would define demonstration purpose and scope, then planning could be done for miscellaneous devices

Suggestions

- Metrics
  - Throughput *(Quan.)*
    - Frame rate
    - Number of connections
  - Stability *(Qual.)*
    - Robustness of system
    - Reaction to bad info
  - Response Latency *(Quan.)*
    - Closed-loop time for command/response
- Tests
  - Throughput
    - Packets/sec
    - Connections before fail
    - Packets/connection
  - Stability
    - Bad packets
    - Bad parameters
    - Recovery
  - Response Latency
    - Time for response from device (status)

Suggestions

- Metrics
  - Action Latency *(Quan.)*
    - Closed-loop time for command/action
  - Prioritization *(Quan.)*
    - Latency & throughput due to low priority CIP or other network traffic
- Tests
  - Action Latency
    - Time for action by device (digital and/or analog)
  - Prioritization
    - Load network with low priority CIP and other traffic, check latency & throughput (multiple loadings)

Suggestions

- Tests should be performed with dedicated device
  - Software-based tests will have same OS related latencies that devices will
- Devices WILL be targeted to work well on tests, but never perform up to specs
  - This can't be stopped, but performance tests will give some basis for comparison between devices